For Reference

NOT TO BE TAKEN FROM THIS ROOM

For Reference

NOT TO BE TAKEN FROM THIS ROOM

Ex libris
Universitatis
Albertaensis

QUAECUMQUE VERA

University

Digitized by the Internet Archive
in 2019 with funding from
University of Alberta Libraries

https://archive.org/details/criteriaforpredi00marg

THE UNIVERSITY OF ALBERTA

CRITERIA FOR PREDICTING SHORTHAND SUCCESS

by

Margaret Irene Benedict

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements for the Degree
of Master of Education

Department of Educational Psychology

Edmonton, Alberta
September, 1964

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Criteria for Predicting Shorthand Success", submitted by Margaret Irene Benedict in partial fulfillment of the requirements for the degree of Master of Education.

ACKNOWLEDGEMENTS

The writer wishes to express appreciation for the privilege of working under the leadership of Dr. C. M. Christensen. This study would not have been possible had it not been for the guidance of Dr. C. M. Christensen, Dr. Geraldine M. Farmer and Dr. S. Hunka.

Appreciation is extended to relatives and friends who gave encouragement and help when it was most needed.

ABSTRACT

The purpose of the study was to find predictors of success in beginning shorthand, Shorthand 10, and in second year shorthand, Shorthand 20. The hope was that these predictors would be effective guides to prospective shorthand students.

The Grade IX Departmental examination marks and the School and College Ability Test scores of Grade X, Shorthand 10 students from the seven Edmonton public high schools were used as variables and and their final Shorthand 10 marks were used as the criterion, in a stepwise multiple regression analysis and in a discriminant analysis.

Science 9, Language 9, SCAT Verbal and Reading 9 were found to be the best predictors of success in Shorthand 10, accounting for 26.25 percent of the variance. Science 9, Language 9 and Reading 9 were found to be the best discriminators between the two Grade X, Shorthand 10 groups, Successful and Unsuccessful.

In the Grade XI stepwise regression analysis and discriminant analysis the Grade X final marks of the students were used together with the Grade IX marks and SCAT scores, making a total of fourteen variables. The criterion variable was the Shorthand 20 final mark.

Shorthand 10 and Language 10 were found to be the best predictors of success in Shorthand 20, accounting for 33.38 percent of the variance. Shorthand 10, SCAT Quantitative and Language 10 discriminated best between the four Grade X, Shorthand 20 groups, Successful, Unsuccessful, Failures and Dropouts.

More research is needed to find other variables that predict success in shorthand. The ones found in this study predict approximately one quarter of the variance in Shorthand 10 and one third in Shorthand 20.

TABLE OF CONTENTS

Chapter Topic Page

I Statement of the Problem 1

II Related Literature 3

III The Design of the Study

Samples 9

Variables and Definitions 9

Design 11

IV Analysis of the Data 14

V Summary, Discussion, Conclusions and Implications

Summary 42

Discussion 44

Conclusions 47

Implications 48

Bibliography 49

LIST OF TABLES

Table	Title	Page
I	Means and Standard Deviations of Variables Used for Regression Analysis Total Grade X Sample	15
II	Intercorrelations between Predictors and Criterion for Grade X Sample	16
III	Results of Stepwise Regression Analysis Total Grade X Sample	17
IV	't' Tests for Beta Weights at Successive Stages Total Grade X Sample	20
V	Means and Standard Deviations of Variables Used for Regression Analysis Total Grade XI Sample	22
VI	Intercorrelations between Predictors and Criterion for Grade XI Sample	24
VII	Results of Stepwise Regression Analysis Total Grade XI Sample	25
VIII	't' Tests for Beta Weights at Successive Stages Total Grade XI Sample	29
IX	Sums of Squares and Crossproducts about the Grand Mean Total Grade X Sample	32
X	Group Means and Difference between Group Means Total Grade X Sample	33
XI	Stepwise Discriminant Function Weights Total Sample Grade X	34
XII	Regression Analysis of the Contributions of each Successive Variable to the Discriminant Function Grade X	36
XIII	Summary of the Means and Variances of the Fourteen Variables for each Grade XI Group	37
XIV	Between Groups Matrix A Discriminant Function Grade XI	39
XV	Weights Discriminant Function Grade XI	41

CHAPTER I

STATEMENT OF THE PROBLEM

Through the years teachers of shorthand in the Alberta High Schools have found that many students drop out of the beginning shorthand classes during the first year. Many students fail shorthand at the end of the first year. Many do not continue on to a second year of shorthand even though they have successfully passed the first year. Some students drop out during the second year of shorthand and some fail at the end of the second year.

Students embark on a business career only to find that they cannot cope with shorthand. Classroom and homework time are wasted in an attempt to memorize countless outlines. Materials are wasted. Shorthand pens, notebooks and textbooks are expensive. Teacher time and effort are wasted. Students become discouraged with their secretarial course and sometimes with their high school program, as a result of this lack of success in shorthand.

Many more students request permission to take shorthand each year than are allowed to do so. Possibly the prerequisites, B or better in Grade IX Language and Reading, being used at present in the Alberta High Schools, are not the best ones. Research is needed to determine the most efficient predictors of success in shorthand.

The purpose of this study was to find the best predictors, among a number of variables, of success in beginning shorthand; and in second-year shorthand. An attempt was also made to find the

variables which discriminated between Successful and Unsuccessful groups in beginning shorthand; and between Successful, Unsuccessful, Failures and Dropouts groups in second year shorthand. This latter calculation also attempted to specify an individual as a member of one of the groups to which he could possibly belong.

CHAPTER II

RELATED LITERATURE

A review of recent studies revealed the need for further research to be carried out on the prediction of success in shorthand, particularly Pitman shorthand. All studies reviewed were concerned with Gregg shorthand, because of the unavailability of research studies in Pitman shorthand.

Dame (1963) says that tests of mental ability and prognostic tests for stenographic ability used in conjunction with English and reading ability are helpful in forecasting success in secretarial work but their predictive accuracy leaves much to be desired. The coefficient of correlation between general I. Q. and success in shorthand is .45 (Larson and Eckersley, 1957). These authors further report that a student's chances for success in shorthand are poor unless he has an I.Q. of at least 95; and that between 80 and 90 percent of pupils with an I. Q. below 100 drop out of shorthand some time during the two year period. Osborne (1943) found that although some degree of relationship exists between intelligence and shorthand achievement, superior intelligence does not assure high achievement in shorthand and low intelligence does not preclude high scores. Also, correlation between intelligence and shorthand achievement suggests that success in shorthand is dependent on intelligence to a lesser degree than success in academic subjects.

Osborne (1943) reports that the success of a pupil in shorthand frequently depends on his desire to master this subject as well as his willingness to spend a great deal of time in studying it.

Desire to learn shorthand, ability to write fairly rapidly, good hearing, good work habits, and the ability to concentrate are necessary for writing notes from shorthand dictation. According to Osborne's research study of 1943, achievement in grammar is the most reliable tool for prognosis, but as many factors as possible should be considered when counseling pupils about shorthand.

The student's reason for electing shorthand was also found to have a very close relationship to shorthand achievement (Whittle, 1962). Ninety-five percent of those who had a permanent vocational objective made C, which is a passing mark, or above in shorthand. Ninety percent of those who were taking it for temporary secretarial employment made C or above. Eighty percent of those planning on Journalism as a career made C or above. Ten percent with no particular reason for studying shorthand made C or above.

The general scholastic average of high school grades, with a correlation coefficient of .586 bears a closer relationship to shorthand achievement than any of the single high school grades investigated (Whittle, 1962). Intercorrelation of each variable with the criterion of success in shorthand, shows that English grades, .695, are most highly related to success in shorthand but are followed closely by scholastic average with .654, spelling with .525, sentences with .461, and verbal reasoning with .381 (Cheney, 1963). The multiple correlation with the shorthand criterion for all variables was .765 but these predictors were almost equalled by the English to spelling correlation of .737 and the English to

general scholastic average of .718 while DAT test variables had a correlation of .576 (Cheney, 1963). The percentage of the total variance of the shorthand criterion accounted for by each of the predictors was English 27.2 percent, general scholastic average 15.6 percent, spelling 12.5 percent, verbal reasoning 1.5 percent, and sentences .2 percent, for a total of 57 percent (Cheney, 1963).

Cheney and Goodish (1963) experimented with cut off scores in English and general scholastic average. They could reduce the number of failures in shorthand by this method but they also lost some successful students.

English grades, particularly spelling and language; and general scholastic average appear to be the best predictors of success in shorthand. Seldon (1961) concluded from his research that a pupil who has done average or better than average work in different subjects, especially English might reasonably be expected to do comparable work in shorthand. He elaborated on this further by stating that perhaps the most important factor to consider is pupil achievement in grammar and usage, punctuation, sentence structure, and spelling. One of the authors in Cheney's and Goodish's (1963) follow-up study, Strickland, recommended that scholastic average, English grades, Turse Shorthand Aptitude scores, DAT Sentences Test and DAT Spelling Tests be used in advising students to select shorthand. In a previous follow-up study Cheney and Goodish found that employed stenographers were above average in all tests but significantly so in spelling.

Whittle (1962), with a correlation of .759 showed that the University of Texas Admission Test (Verbal, Numerical, Total) was the best predictor of success in shorthand in college, but that the general scholastic average, and the Texas English Placement scores (Reading Comprehension, Unit Examination) were also valuable in predicting success in shorthand in high school. Larson and Eckersley (1957) found that there is a fairly high correlation between vocabulary tests and achievement in shorthand; between reading comprehension and mechanics of expression and achievement in shorthand; and between foreign language aptitude tests and shorthand.

Some writers state that the prediction correlations are too low and that students should not be denied the privilege of attempting shorthand if they so desire. Larson and Eckersley (1957) in the results of their study as stated in the above paragraph, concluded that the relationship between these test scores and achievement has been too low to merit their acceptance for this purpose. Whittle (1962) found that the actual grade college students made in beginning shorthand could not be predicted accurately, only whether they could make above or below average grades. In Cheney's and Goodish's (1963) follow-up study, Meyer, found that shorthand dropouts were different from the successful students but that they were alike to such a degree that refusing any student the opportunity to take shorthand was not justified. She suggested that the criterion to be used for rejecting students should be one that would predict accurately and and that it should not reject students who would be successful.

Dame (1963) pointed out in his study that there is a significant lack of agreement among investigators concerning prognosis. He suggested that it might be better to rely upon school subjects themselves as the basis for prediction for success in shorthand. If this were done every student would try shorthand if he chose.

Strickland, in Cheney's and Goodish's (1963) follow-up study recommended that the Turse Shorthand Aptitude scores, among others, be used in advising students to select shorthand. Pauk (1963) finds in his study that the Turse Test is not very useful in predicting shorthand success. The correlation of the subtests of the Turse Shorthand Aptitude test with success in shorthand were: Stroking .04, Dictation .18, Symbol Translation .37, Total of the three preceding nonverbal subtests .34, Spelling .56, Phonetic Association .58, Word Discrimination .62, Word Sense .63, Total of the four preceding verbal subtests .66, Total Turse Test .63. The correlation of the Linguistic score of the American College Entrance examination with success in shorthand is .63.

The implication of this finding, according to Pauk, is that in schools where the American College Entrance Examination is administered as part of the regular battery of tests, the Linguistic score alone may be used in place of the Turse Test. In schools where the American College Examination is not used, the linguistic scores of some other standardized tests might predict shorthand success as well as the Turse Test (Pauk, 1963). The administration of the

Turse Test is time consuming. It takes sixty minutes to administer and fifteen minutes to hand score.

Allyn (1962) tried to develop a shorthand aptitude test using recognized shorthand strokes in its construction. His results were as follows: Most of the individual subtests showed slight to negligible relationship with the achievement criteria. The multiple correlations for the high school groups indicated a relationship of some value. The test battery seemed to predict success more effectively, even though slight, among secondary school students than among junior college students. Among secondary school students the battery seemed to predict success more effectively at the end of the first semester than at the end of the second semester.

CHAPTER III

THE DESIGN OF THE STUDY

The sample is from the population of the students who are registering in Shorthand 10 in the Edmonton Public High Schools.

The students involved in this study attended the seven Public high schools in the city of Edmonton, Bonnie Doon Composite High School, Eastglen Composite High School, Queen Elizabeth Composite High School, Ross Shepherd Composite High School, Strathcona Composite High School, Victoria Composite High School and Victoria Vocational High School.

Grade X students who registered in Shorthand 10 in 1963-64, 302 in number, and Grade X students who registered in Shorthand 10 in 1962-63, 344 in number were included. The 344 who registered in 1962-63 were called the Grade XI, Shorthand 20 students. Of this number, 171 were registered in Grade XI, Shorthand 20, during the school year 1963-64. The other 173 either failed Shorthand 10 at the end of June, 1963, or dropped out of the program.

There were complete test data available on the 302 Grade X students and on the 171 Grade XI students. The Failures and Drop-outs groups did not have year end marks in Shorthand 20.

VARIABLES AND DEFINITIONS

1. Grade X, Shorthand 10 students were those students who studied beginning shorthand in the first year of high school.

2. Grade XI, Shorthand 20 students were those students who studied second year shorthand in the second year of high school and

had already passed Shorthand 10.

3. Grade IX Departmental examination marks were those marks obtained by students on Province wide common examinations in Reading, Literature, Language, Social Studies, Mathematics and Science. Grade IX is the final year of school prior to entrance into high school.

4. The School and College Ability Tests (SCAT) are standardized tests of general academic aptitude, yielding separate Verbal and Quantitative scores.

SCAT Verbal is designed to measure ability to understand sentences and give the meaning of words.

SCAT Quantitative is designed to measure ability to perform operations with numbers and to solve mathematics problems stated in words.

5. The Grade X year end marks in Literature 10, Language 10, Social Studies 10, Physical Education 10, Shorthand 10, and Typewriting 10 were the final marks assigned at the end of the year to first year high school students in the first high school year of Literature, Language, Social Studies, Physical Education, Shorthand and Typewriting, respectively.

6. The Grade X, Group I, Successful group, for purposes of this study, were the students who could take practiced dictation at 60 words per minute or more. Teachers and coordinators of the schools were contacted by telephone for their opinions on this dividing line. A mark of 65 percent or over on the Grade X, Shorthand final report was suggested.

7. The Grade X, Group II, Unsuccessful group, were the students who could not take practiced dictation at 60 words per minute. This group included every Grade X, Shorthand 10 student who had a final mark below 65 percent in Shorthand 10.

8. The Grade XI, Group I, Successful group were students who could take dictation on unfamiliar material at 80 words per minute or more and transcribe it accurately. On consultation with teachers and coordinators a final mark of 65 percent or over in Shorthand 20 was again suggested as the dividing line.

9. The Grade XI, Group II, Unsuccessful group, were students who could not take dictation on strange material at 80 words per minute. Their final Shorthand 20 marks were below 65 percent.

10. The Grade XI, Group III, Failures group, were unable to continue on to Shorthand 20 because they had failed the prerequisite, Shorthand 10.

11. The Grade XI, Group IV, Dropouts group, was composed of those students who passed Shorthand 10 but who did not attempt Shorthand 20.

DESIGN

The study was designed to process the data in four separate analyses. The first two were multiple regression analyses, one for the 302 Grade X students and one for the 171 Grade XI students for whom complete data were available. The last two were discriminant analyses for purposes of differentiating between specified groups

and for assigning individuals to the groups. The first discriminant analysis was for the two Grade X groups, the Successful group of 173 members and the Unsuccessful group of 129 members. The second discriminant analysis was for the four Grade XI groups, the Successful group of 94 members, the Unsuccessful group of 77 members, the Failures group of 86 members and the Dropouts group of 87 members.

1. A multiple stepwise regression analysis was used to examine the relation between a criterion, or dependent variable, the Grade X, Shorthand 10 final mark; and eight predictors, or independent variables, the Grade IX final marks in Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, Science 9, SCAT Verbal and SCAT Quantitative.

2. Similarly, a stepwise regression analysis was used to examine the relation between a criterion, the Grade XI, Shorthand 20 final mark; and fourteen predictors, the Grade IX final marks in Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, Science 9, SCAT Verbal, SCAT Quantitative, the Grade X final marks in Literature 10, Language 10, Social Studies 10, Physical Education 10, Shorthand 10 and Typewriting 10. The above mentioned Grade IX and Grade X marks were used because they were common to every Grade X and Grade XI student, respectively, in the study.

3. A stepwise discriminant analysis was used to construct a discriminant function which afforded the maximum discrimination between the two Grade X groups, Successful and Unsuccessful, into which the subjects had been classified. The variables used as

discriminators were the six Grade IX Departmental examination marks and the two School and College Ability Test scores, as in 1. above.

4. Multiple discriminant analysis was used to find the variables which received the highest weighting in discriminating between the four groups into which the Grade XI, Shorthand 20 students had been divided, Successful, Unsuccessful, Failures and Dropouts.

The discriminant analysis was also used in both Grade X and Grade XI in an attempt to specify a student as a member of one of the groups to which he could possibly belong; Successful or Unsuccessful in Grade X, and Successful, Unsuccessful, Failures or Dropouts in Grade XI.

CHAPTER IV

ANALYSIS OF THE DATA

The data were processed by an IBM 1620 computer.

A multiple regression analysis was computed using a stepwise procedure. This process involved the calculation of a regression equation using the predictor variable that accounted for the greatest amount of variance of the criterion. At each step the variable accounting for the next greatest amount of remaining variance was added to the regression equation.

The multiple regression analysis, Grade X, estimated the relationship between a "dependent" variable, Grade X, Shorthand 10 final mark and a set of eight "independent" variables, Grade IX Departmental examination marks in Reading 9, Language 9, Social Studies 9, Mathematics 9, Science 9, the School and College Ability Test scores, Verbal and Quantitative, in such a way as to make the best prediction of the dependent variable.

Table I shows the means and standard deviations for all the variables for the Grade X regression analysis.

Table II gives the correlation of each variable with every other variable used in the multiple regression analysis. The variables having the highest correlation with Shorthand 10 are Science 9 .418, Language 9 .397 and Social Studies 9 .370. These same variables have a high correlation with each other. The correlation between Science 9 and Language 9 is .576, between Science 9 and Social Studies 9 is .796 and between Language 9 and Social Studies 9 is .601. If variables have a fairly high correlation

TABLE I

MEANS AND STANDARD DEVIATIONS OF VARIABLES USED FOR REGRESSION ANALYSIS TOTAL GRADE X SAMPLE

Variable	$\bar{X}$	S
Reading 9	65.086	13.235
Literature 9	65.695	12.474
Language 9	68.831	11.291
Social Studies 9	63.106	14.063
Mathematics 9	63.619	13.360
Science 9	63.384	14.013
SCAT Verbal	46.156	7.366
SCAT Quantitative	37.305	6.538
Shorthand 10	65.623	19.030

with the criterion and a low correlation with each other, each variable measures different aspects of the criterion and each will contribute substantially to the prediction. The variables, Science 9, Language 9 and Social Studies 9 have a fairly high correlation with Shorthand 10 and a high correlation with each other so are measures of much the same thing in the prediction. The correlation between the variable, SCAT Verbal, and Shorthand 10 is low, .075. This variable, SCAT Verbal, is a suppressor variable and tends to make certain predictors better predictors by taking away that part of the predictor variance that is not held in common with the criterion.

TABLE II

INTERCORRELATIONS BETWEEN PREDICTORS AND CRITERION FOR GRADE X SAMPLE

	Read.	Lit.	Lang.	S. S.	Math.	Sci.	Verb.	Quant.	Short.10
Read. 9		.482	.308	.402	.197	.278	.561	.291	-.029
Lit. 9			.438	.571	.399	.531	.413	.394	.261
Lang. 9				.601	.438	.576	.466	.452	.397
S. S. 9					.586	.796	.534	.483	.370
Math. 9						.672	.307	.714	.349
Science 9							.475	.556	.418
SCAT Verb.								.351	.075
SCAT Quant.									.281

Reading, having a correlation of -.029 with Shorthand 10 is also a suppressor variable.

Table III shows the weights at each step of the regression analysis. Step 1 indicates that the variable, Science, can predict 17.51 percent of the variance of the criterion. In Step 2, when the variable, Language is added to the regression equation, 21.15 percent of the variation in the criterion is predictable. Science, Language, and SCAT Verbal predict 25.08 percent of the variation in Shorthand 10 in Step 3. Science, Language, SCAT Verbal and Reading account for 26.25 percent of the variation. When Literature is added, the variance accounted for is 27.03 percent. The addition

TABLE III

RESULTS OF STEPWISE REGRESSION ANALYSIS
TOTAL GRADE X SAMPLE

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
1	29.607	.568	17.51	.41	Science 9
2	14.090	.386	17.51		Science 9
		.394	3.64		Language 9
			21.15	.46	
3	27.934	.484	17.51		Science 9
		.507	3.64		Language 9
		-.604	3.93		SCAT Verb.
			25.08	.50	
4	30.960	.481	17.51		Science 9
		.522	3.64		Language 9
		-.422	3.93		SCAT Verb.
		-.188	1.17		Reading 9
			26.25	.51	
5	28.301	.092	17.51		Science 9
		.497	3.64		Language 9
		-.417	3.93		SCAT Verb.
		-.246	1.17		Reading 9
		.176	.78		Literature 9
			27.03	.52	
6	29.739	.332	17.51		Science 9
		.469	3.64		Language 9
		-.445	3.93		SCAT Verb.
		-.260	1.17		Reading 9
		.155	.78		Literature 9
		.156	.39		S. Studies 9
			27.42	.52	
7	27.546	.300	17.51		Science 9
		.453	3.64		Language 9
		-.446	3.93		SCAT Verb.

TABLE III (Continued)

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
		-.268	1.17		Reading 9
		.149	.78		Literature 9
		.164	.21		SCAT Quant.
			27.63	.53	
8	27.298	.285	17.51		Science 9
		.450	3.64		Language 9
		-.439	3.93		SCAT Verb.
		-.265	1.17		Reading 9
		.149	.78		Literature 9
		.152	.39		S. Studies 9
		.113	.21		SCAT Quant.
		.050	.05		Mathematics 9
			27.68	.53	

of Social Studies 9 increases the prediction to 27.42 percent, SCAT Quantitative, to 27.63, and finally Mathematics 9, to make a total of 27.68 percent of the variance accounted for in Shorthand 10 when the eight variables are used.

The evaluation of the relative contributions of the different variables is not a simple matter of direct comparison of the relative magnitudes of the regression coefficients but is complicated by changes in the coefficients with an increased number of variables used. Frequently, in practical work, the greater part of the prediction achieved can be attributed to a relatively small number of variables, perhaps four or five or six, and the inclusion of

additional variables contributes only small and diminishing amounts to the prediction.

The best single predictor of Grade X, Shorthand 10 success is Science 9; the best group of two predictors is Science 9 and Language 9; the best group of three is Science 9, Language 9, and SCAT Verbal. Three predictors appear to be an optimum number to use; 25.08 percent of the variance in the criterion is accounted for at this point. By adding the remaining variables in order, up to eight, only 27.68 percent of the variance is accounted for, 2.60 percent more. The small amount of information that would be added would contribute a negligible amount to the efficacy of the prediction.

Table III shows the constants and weights needed for the regression equation. If Science 9 alone were used as a predictor, the regression equation would be $P = C_1 + WX_1$, where P is the student's predicted score in Shorthand 10, C is the constant, W is the weight and X_1 is the student's mark in Science 9. If the student's mark in Science 9 were 35 percent, the prediction score would be $29.607 + (.568 \times 35) = 49.487$. If a Successful student is one who obtains 65 percent or over in Shorthand 10, as has been suggested in this study, the student in this example would fall into the Unsuccessful category.

The regression equation, if Science 9 and Language 9 were used, would be $P = C_2 + WX_1 + WX_2 = 14.090 + .386X_1 + .394X_2$.

Table III shows the Multiple Correlation of the predictor

variables with the criterion variable, Shorthand 10. The variables, Science 9, Language 9, and SCAT Verbal have a multiple correlation of .50 with Shorthand 10. The addition of the remaining five variables to the regression equation adds only .03 to the multiple correlation.

Table IV shows the significance of the 't' tests for the beta weights. For this data it would appear that the first four predictors, Science 9, Language 9, SCAT Verbal and Reading 9 would stand up to cross validation. The beta weights at the first four stages are significant at the .01 level.

TABLE IV

't' TESTS FOR BETA WEIGHTS AT SUCCESSIVE STAGES
TOTAL GRADE X SAMPLE

Beta Weights	Stages 1	2	3	4	5	6	7	8
1	7.97*							
2	4.52*	3.71*						
3	5.56*	4.72*	-3.95*					
4	5.56*	4.88*	-2.43*	-2.16*				
5	4.60*	4.63*	-2.41*	-2.66*	1.77			
6	2.85*	4.28*	-2.55*	-2.79*	1.54	1.26		
7	2.46*	4.09*	-2.56*	-2.87*	1.48	1.28	.91	
8	2.24*	4.04*	-2.50*	-2.82*	1.48	1.22	.52	.42

* Significant at the .01 level.

A similar stepwise procedure was used in the multiple regression analysis of the Grade XI data. Only the 171 students enrolled in Shorthand 20 in 1963-64 were included because they were the only ones with a Shorthand 20 final mark. The regression analysis estimated the relationship between the Shorthand 20 final mark, and the variables, Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, Science 9, SCAT Verbal, SCAT Quantitative, Literature 10, Language 10, Social Studies 10, Physical Education 10, Shorthand 10, and Typewriting 10, in such a way as to make the best prediction of the dependent variable, the Shorthand 20 final mark. These fourteen variables were used because every student in the sample had a final mark in each one.

The multiple regression equation summed up all the evidence of the observations into a single statement which expressed, in condensed form, the extent to which difference in the dependent variable tended to be associated with differences in each of the other variables.

Table V shows the means and standard deviations for all the variables in the Grade XI stepwise regression analysis.

Table VI gives the correlation of each variable with every other variable used in the analysis. The correlation of Shorthand 20 with Shorthand 10 is .505, with Language 10 is .457, with Social Studies 10 is .400. The correlation of Shorthand 10 with Language 10 is .396, of Shorthand 10 with Social Studies 10 is .369 and of Language 10 with Social Studies 10 is .612. The correlation of each

TABLE V

MEANS AND STANDARD DEVIATIONS OF VARIABLES USED FOR REGRESSION ANALYSIS TOTAL GRADE XI SAMPLE

Variable	$\bar{X}$	S
Reading 9	62.398	13.704
Literature 9	66.211	11.818
Language 9	65.690	10.794
Social Studies 9	58.912	12.604
Mathematics 9	57.363	13.523
Science 9	56.515	13.481
SCAT Verbal	39.187	8.930
SCAT Quantitative	34.363	7.200
Literature 10	64.883	11.114
Language 10	63.392	7.815
Social Studies 10	58.714	11.948
Physical Education 10	59.240	8.507
Shorthand 10	68.006	12.069
Typewriting 10	64.526	11.477
Shorthand 20	64.351	13.903

variable with every other variable is fairly high and the correlation of each variable with the criterion variable is quite high, so probably all measure approximately the same aspects of the criterion and each added variable does not add much to the prediction. Short-

hand 10 alone is a satisfactory predictor of success in Shorthand 20. Shorthand 10, Language 10 and Social Studies 10 were the three most significant variables in the regression equation. Table VII shows the variation in the weights when another variable is added to the regression equation. Step 1 indicates that the variable, Shorthand 10 predicts 25.53 percent of the variation in Shorthand 20. Step 2 shows that Shorthand 10 and Language 10 together predict 33.38 percent. Step 3 shows that Shorthand 10, Language 10 and Social Studies 10 together predict 34.22 percent. If all fourteen variables were added, 37.40 percent of the variation in the criterion variable, Shorthand 20 would be predicted, which is only 3.18 percent more than when three variables are used as a group. If a student has successfully completed Shorthand 10, Language 10 and Social Studies 10, it might be expected that he will successfully complete Shorthand 20.

Table VII, Step 1, shows the multiple correlation between the predictor variable, Shorthand 10, and the criterion variable, Shorthand 20, to be .51. Step 2 shows that the multiple correlation between Shorthand 10 and Language 10 together, and Shorthand 20 is .58. Step 14 shows that the multiple correlation of the fourteen predictor variables with Shorthand 20 is .61. The efficiency of the prediction is not increased very much by adding more variables, only .03 is added to the multiple correlation from Step 2 to Step 14.

The regression equations may be constructed by using the infor-

TABLE VI

INTERCORRELATIONS BETWEEN PREDICTORS AND CRITERION FOR GRADE XI SAMPLE

	Lit. 9	Lang. 9	S. S. 9	Math. 9	Science 9	SCAT Verb.	SCAT Quant.	Lit. 10	Lang. 10	S. S. 10	Phys. Ed.10	Short. 10	Typ. 10	Short. 20
Read.9	.518	.563	.523	.389	.586	.702	.464	.396	.444	.450	-.010	.197	.221	.190
Lit. 9		.599	.588	.444	.572	.601	.437	.487	.541	.494	.040	.226	.177	.293
Lang. 9			.497	.472	.571	.538	.483	.382	.525	.341	-.050	.253	.229	.283
S. Studies 9				.540	.753	.684	.462	.544	.597	.701	.071	.277	.292	.319
Math. 9					.713	.342	.665	.214	.381	.219	.088	.236	.241	.141
Science 9						.587	.544	.464	.570	.523	.061	.286	.261	.228
SCAT Verb.							.429	.520	.501	.560	-.034	.111	.135	.257
SCAT Quant.								.253	.368	.185	-.035	.200	.184	.175
Lit. 10									.704	.648	.148	.344	.090	.360
Lang. 10										.612	.198	.396	.193	.457
S. Studies 10											.226	.369	.177	.400
Phys. Ed. 10												.142	-.066	.065
Short. 10													.408	.505
Typ. 10														.260

TABLE VII

RESULTS OF STEPWISE REGRESSION ANALYSIS TOTAL GRADE XI SAMPLE

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
1	24.764	.582	25.53	.51	Short. 10
2	- .180	.443	25.53		Short. 10
		.543	7.87		Lang. 10
			33.38	.58	
3	.501	.423	25.53		Short. 10
		.427	7.85		Lang. 10
		.137	.84		S. S. 10
			34.22	.59	
4	- .333	.427	25.53		Short. 10
		.511	7.85		Lang. 10
		.175	1.80		S. S. 10
		-.125	.92		Science 9
			35.14	.59	
5	- 1.769	.450	25.53		Short. 10
		.482	7.85		Lang. 10
		.132	.84		S. S. 10
		-.167	.92		Science 9
		.170	.64		SCAT Verb.
			35.78	.60	
6	- 4.195	.418	25.53		Short. 10
		.489	7.85		Lang. 10
		.137	.84		S. S. 10
		-.180	.92		Science 9
		.166	.64		SCAT Verb.
		.085	.39		Typ. 10
			36.17	.60	
7	- 4.195	.423	25.53		Short. 10
		.492	7.85		Lang. 10
		.135	.84		S. S. 10

TABLE VII (Continued)

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
		-.158	.92		Science 9
		.249	.64		SCAT Verb.
		.093	.39		Typ. 10
		-.976	.42		Read.
			36.59	.61	
8	- 5.692	.417	25.53		Short. 10
		.451	7.85		Lang. 10
		.154	.84		S. S. 10
		-.178	.92		Science 9
		.223	.64		SCAT Verb.
		.088	.39		Typ. 10
		-.117	.42		Read. 9
		.107	.36		Lang. 9
			36.95		
9	- 1.534	.421	25.53		Short. 10
		.469	7.85		Lang. 10
		.168	.84		S. S. 10
		-.177	.92		Science 9
		.206	.64		SCAT Verb.
		.804	.39		Typ. 10
		-.116	.42		Read. 9
		.098	.36		Lang. 9
		-.811	.21		Phys. Ed. 10
			37.24	.61	
10	- 1.894	.421	25.53		Short. 10
		.460	7.85		Lang. 10
		.162	.84		S. S. 10
		-.182	.92		Science 9
		.192	.64		SCAT Verb.
		.080	.39		Typ. 10
		-.116	.42		Read. 9
		.083	.36		Lang. 9
		-.081	.21		Phys. Ed. 10
		.047	.08		Lit. 9
			37.24	.61	

TABLE VII (Continued)

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
11	- 1.653	.426	25.53		Short. 10
		.496	7.85		Lang. 10
		.177	.84		S. S. 10
		-.183	.92		Science 9
		.203	.64		SCAT Verb.
		.075	.39		Typ. 10
		-.118	.42		Read. 9
		.081	.36		Lang. 9
		-.083	.21		Phys. Ed. 10
		.050	.08		Lit. 9
		-.055	.08		Lit. 10
			37.32	.61	
12	- 2.055	.424	25.53		Short. 10
		.493	7.85		Lang. 10
		.185	.84		S. S. 10
		-.192	.92		Science 9
		.199	.64		SCAT Verb.
		.075	.39		Typ. 10
		-.121	.42		Read. 9
		.772	.36		Lang. 9
		-.083	.21		Phys. Ed. 10
		.047	.08		Lit. 9
		-.054	.08		Lit. 10
		.044	.03		SCAT Quant.
			37.35	.61	
13	- 2.109	.425	25.53		Short. 10
		.494	7.85		Lang. 10
		.178	.84		S. S. 10
		-.166	.92		Science 9
		.193	.64		SCAT Verb.
		.077	.39		Typ. 10
		-.124	.42		Read. 9
		.079	.36		Lang. 9
		-.076	.21		Phys. Ed. 10
		.051	.08		Lit. 9
		-.059	.08		Lit. 10
		.074	.03		SCAT Quant.

TABLE VII (Continued)

Step	Regression Constant	Beta Weights	Variance Accounted for by the Regression Equation	Multiple Correlation R	Variable Added
		-.414	.05		Math. 9
			37.40	.61	
14	- 2.052	.426	25.53		Short. 10
		.493	7.85		Lang. 10
		.173	.84		S. S. 10
		-.170	.92		Science 9
		.188	.64		SCAT Verb.
		.076	.39		Typ. 10
		-.122	.42		Read. 9
		.080	.36		Lang. 9
		-.076	.21		Phys. Ed. 10
		.050	.08		Lit. 9
		-.059	.08		Lit. 10
		.073	.03		SCAT Quant.
		-.043	.05		Math. 9
		.013	.00		S. S. 9
			37.40	.61	

mation in Table VII.

Step 1 $P = C_1 + WX_1 = 24.764 + .582X_1$.

X_1 is the student's mark in Shorthand 10.

Step 2 $P = C_2 + WX_1 + WX_2 = -.180 + .443X_1 + .543X_2$.

X_2 is the student's mark in Language 10.

Table VIII shows the significance of the 't' tests for the beta weights. For this data it would appear that the first two predictors, Shorthand 10 and Language 10 would stand up to cross validation. The beta weights at the first two stages are significant at the .01 level.

TABLE VIII

't' TESTS FOR BETA WEIGHTS AT SUCCESSIVE STAGES TOTAL GRADE XI SAMPLE

Beta Weights	Stages 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	7.61*													
2	5.60*	4.44*												
3	5.28*	2.94*	1.45											
4	5.35*	3.30*	1.80	-1.53										
5	5.52*	3.08*	1.29	-1.90	1.28									
6	4.79*	3.12*	1.33	-2.03	1.24	1.00								
7	4.83*	3.14*	1.31	-1.72	1.60	1.09	-1.03							
8	4.75*	2.78*	1.47	-1.89	1.41	1.04	-1.21	.96						
9	4.78*	2.86*	1.58	-1.87	1.29	.94	-1.20	.87	- .74					
10	4.77*	2.78*	1.51	-1.91	1.17	.93	-1.20	.71	- .74	.44				
11	4.78*	2.69*	1.57	-1.92	1.22	.86	-1.21	.68	- .75	.46	- .44			
12	4.72*	2.65*	1.59	-1.91	1.19	.86	-1.23	.65	- .74	.43	- .43	.27		
13	4.71*	2.65*	1.52	-1.36	1.14	.88	-1.25	.66	- .67	.46	- .47	.41	- .36	
14	4.69*	2.63*	1.32	-1.32	1.05	.84	-1.21	.66	- .67	.46	- .47	.40	- .37	.09

* Significant at the .01 level.

The second type of analysis used in this study was the discriminant analysis which attempted to specify an individual as a member of one of many groups to which he could possibly belong (Rao, 1952). For purposes of this study the Grade X groups were the Successful group and the Unsuccessful group; the Grade XI groups were the Successful, Unsuccessful, Dropouts and Failures groups.

The discriminant analysis attempted also to classify the groups themselves into some significant system based on the configuration of the various characteristics (Rao, 1952), Successful and Unsuccessful in Grade X; Successful, Unsuccessful, Failures and Dropouts in Grade XI.

The multiple character case is reduced to that of a single variate by replacing the several measurements by a suitably chosen linear compound (Rao, 1952).

The groups overlap to a large extent so that even by following the best procedure the percentage of wrong classifications remains quite high. By increasing the number of characters this percentage could be made smaller and smaller but not always below a reducable minimum.

A stage may be reached at which the cost involved in further examination will not be commensurate to the reduction in the number of wrong classifications. But subject to a given cost the indicators can be chosen so as to minimize the number of wrong classifications. Thus one has to balance between the errors committed and the time or money available (Rao, 1952).

For the Grade X discriminant analysis there was a set of measurements of eight variables, Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, Science 9, SCAT Verbal and SCAT Quantitative. The 302 Grade X Shorthand 10, individuals were calssified into two groups, 173 in Group I, the Successful group, and 129 in Group II, the Unsuccessful group. The problem to be solved was, what combination of the various measurements would best discriminate between the two groups.

A stepwise analysis was made. The variable contributing the least to the discrimination at each step was eliminated. Mathematically, the problem may be viewed as maximizing the ratio of the between groups to the within groups variances. It is necessary to find the linear function of the variables, the discriminant function, that will distinguish better than any other linear function between the two groups.

Table IX shows the sums of squares and crossproducts about the grand mean for the total Grade X sample.

Table X shows the Group I means, the Group II means, and the difference between Group I and Group II means for each variable. The group means are higher for each variable in Group I, ranging from a .2373 difference in the case of Reading to a 10.563 difference in Science.

Table XI shows the order of importance of the variables in the discriminant function. The variable, Literature 9, was eliminated from the matrix first because its sum of squares due to that variable

TABLE IX

SUMS OF SQUARES AND CROSSPRODUCTS ABOUT THE GRAND MEAN
TOTAL GRADE X SAMPLE

	Read. 9	Lit. 9	Lang. 9	S. S. 9	Math. 9	Sci. 9	SCAT Verb.	SCAT Quant.
Read. 9	44,820.90	19,941.70	15,885.20	25,030.10	12,817.10	18,981.20	18,263.85	7,655.18
Lit. 9		39,827.80	22,401.90	32,638.70	22,594.70	29,453.20	12,689.14	10,074.69
Lang. 9			38,370.50	28,707.50	21,416.70	27,416.70	11,656.95	10,040.55
S. S. 9				59,526.70	33,160.20	47,206.80	16,651.03	13,371.28
Math. 9					53,721.30	37,859.20	9,093.93	18,775.06
Sci. 9						59,105.60	14,744.98	15,321.67
SCAT Verb.							16,329.69	5,090.70
SCAT Quant.								12,868.00

The total sum of squares was 73.897.

TABLE X

GROUP MEANS AND DIFFERENCE BETWEEN GROUP MEANS TOTAL GRADE X SAMPLE

Variable	Group I Means	Group II Means	Difference
Reading 9	65.850	65.612	+ .237
Literature 9	68.694	62.930	+ 5.763
Language 9	72.260	64.233	+ 8.028
S. Studies 9	67.058	57.806	+ 9.252
Mathematics 9	67.150	58.884	+ 8.267
Science 9	67.896	57.333	+10.563
SCAT Verb.	46.740	45.372	+ 1.368
SCAT Quant.	38.561	35.620	+ 2.941

was the lowest and thus contributed the least to discriminating between groups. SCAT Quantitative was the second variable to be eliminated, followed by Mathematics 9, SCAT Verbal, Social Studies 9, Reading 9, Language 9, and Science 9, in that order. Science 9, Language 9 and Reading 9 are the variables which have the most effect on the discriminant function. These three, Science 9, Language 9 and Reading 9 discriminate best between Group I, the Successful group and Group II, the unsuccessful group.

Table XII shows that the variance ratios are significant at all steps at the .01 level.

For the Grade XI, discriminant analysis there were 344 individ-

TABLE XI

STEPWISE DISCRIMINANT FUNCTION WEIGHTS
TOTAL SAMPLE GRADE X

Variable	Coefficient	Sums of Squares due to coefficient
Reading 9	-.0070	1.1186
Literature 9	.0004	.0027
Language 9	.0107	2.3916
S. Studies 9	.0034	.1905
Mathematics 9	.0025	.1226
Science 9	.0078	1.0454
SCAT Verb.	-.0051	.1985
SCAT Quant.	-.0020	.0234
Reading 9	-.0070	1.1243
Language 9	.0108	2.5388
S. Studies 9	.0035	.2158
Mathematics 9	.0025	.1246
Science 9	.0079	1.0594
SCAT Verb.	-.0051	.1963
SCAT Quant.	-.0020	.0227
Reading 9	-.0071	1.1643
Language 9	.0107	2.5160
S. Studies	.0035	.2259
Mathematics 9	.0019	.1045
Science 9	.0078	1.0418
SCAT Verb.	-.0052	.2052
Reading 9	-.0071	1.1591
Language	.0110	2.7273
S. Studies 9	.0038	.2557
Science 9	.0087	1.5661
SCAT Verb.	-.0055	.2286
Reading 9	-.0088	2.6177
Language 9	.0105	2.5553
S. Studies 9	.0035	.2200
Science 9	.0084	1.4572
Reading 9	-.0081	2.3978
Language 9	.0112	3.0771
Science 9	.0106	4.2574

TABLE XI

STEPWISE DISCRIMINANT FUNCTION WEIGHTS
TOTAL SAMPLE GRADE X

Variable	Coefficient	Sums of Squares due to coefficient
Language 9	.0090	2.0828
Science 9	.0090	3.2195
Science 9	.0132	10.3080

uals in the sample. They were classified into four groups, Group I, the Successful group with 94 members, Group II, the Unsuccessful group with 77 members, Group III, the Failures group with 86 members, and Group IV, the Dropouts group with 87 members. There were marks or scores on the following set of fourteen variables, Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, Science 9, SCAT Verbal, SCAT Quantitative, Literature 10, Language 10, Social Studies 10, Physical Education 10, Shorthand 10, and Typewriting 10. The problem was to find the relative importance of the variables which would best discriminate between the four groups.

Table XIII gives the group means of each variable for the four groups and the variance of each variable. The group means for every variable are the highest in Group I, the Successful group. The group means for all the variables except Literature 9, Literature 10, and Physical Education 10, which are third highest, are second highest in Group III, the Failures group. Group II means for each

TABLE XII

REGRESSION ANALYSIS OF THE CONTRIBUTIONS OF EACH SUCCESSIVE VARIABLE TO THE DISCRIMINANT FUNCTION GRADE X

Step	Group Mean $\bar{Z}_1$	Group Mean $\bar{Z}_2$	R^2	R	Source	Degrees of Freedom	Sums of Squares	Mean Square	F Ratio	Variable Deleted	Significance
1	.9432	.7352	.2080	.4560	Regression	8	15.3672	1.9209	9.6159	Lit. 9	**
					Error	293		.1998			
2	.9386	.7306	.2079	.4560	Regression	7	15.3644	2.1949	11.0247	SCAT Quant.	**
					Error	294		.1991			
3	.9555	.7479	.2076	.4556	Regression	6	15.3417	2.5569	12.8817	Math. 9	**
					Error	295		.1985			
4	.9184	.7122	.2062	.4541	Regression	5	15.2371	3.0474	15.3774	SCAT Verb.	**
					Error	296		.1982			
5	.9814	.7783	.2031	.4507	Regression	4	15.0085	3.7521	18.9235	S. S. 9	**
					Error	297		.1983			
6	.9991	.7990	.2001	.4473	Regression	3	14.7885	4.9295	24.8523	Read. 9	**
					Error	298		.1984			
7	1.2640	1.0963	.1677	.4095	Regression	2	12.3908	6.1954	30.1174	Lang. 9	**
					Error	299		.2057			
8			.1395	.3735	Regression	1	10.3080	10.3080	48.6306	Science 9	**
					Error	300		.2120			

** Significant at the .01 level.

TABLE XIII

SUMMARY OF THE MEANS AND VARIANCES OF THE FOURTEEN VARIABLES FOR EACH GRADE XI GROUP

Variable	Group 1 (94)		Group 2 (77)		Group 3 (86)		Group 4 (87)	
	$\bar{X}$	S^2	$\bar{X}$	S^2	$\bar{X}$	S^2	$\bar{X}$	S^2
Read. 9	64.66	209.60	59.64	144.37	64.00	203.40	58.94	187.87
Lit. 9	68.72	139.05	63.14	134.64	62.65	185.95	56.80	126.91
Lang. 9	68.55	113.58	62.19	97.48	65.92	124.36	58.87	94.60
S. S. 9	61.63	-484.74	55.60	142.63	56.69	158.86	50.61	100.02
Math. 9	58.93	220.99	55.45	163.71	57.05	160.93	47.26	-225.44
Science 9	58.94	187.91	53.56	155.25	54.94	174.65	48.53	88.43
SCAT Verb.	40.86	88.49	37.14	60.80	40.51	67.01	38.18	72.82
SCAT Quant.	35.50	52.55	32.97	47.04	34.40	44.71	29.90	53.66
Lit. 10	67.82	125.18	61.30	88.41	61.28	135.46	54.54	144.64
Lang. 10	66.06	58.42	60.13	44.77	61.22	102.40	53.33	80.28
S. S. 10	62.18	128.06	54.48	126.41	58.08	173.52	47.99	140.35
Phys.Ed.10	59.62	83.89	58.77	56.15	56.63	106.36	53.79	96.87
Short. 10	73.13	139.51	61.75	80.13	62.79	142.88	38.28	73.15
Typ. 10	67.12	128.96	61.36	115.15	62.91	227.98	52.01	126.68

variable, with the exception of Literature 9, Literature 10 and Physical Education 10 which are second highest, and SCAT Verbal, which is fourth or lowest; are third highest. Group IV means, the Dropouts group, are the lowest with the exception of SCAT Verbal which is third highest.

The Grade XI multiple discriminant analysis for the four groups was not a stepwise procedure and therefore the weights of all the variables were calculated. In calculating the discriminant function, the ratio of among groups variance to within groups variance is maximized. This leads to the following characteristic equation:

$$(W^{-1} - bI)\ V = 0 \qquad (1)$$

where W̲ is the pooled within groups deviation scores and cross product matrix and A̲ is the among groups cross product matrix (Cooley and Lohnes, 1962).

Because $W^{-1}A$ is non symetric the matrix W is broken up into its characteristic root and vector $W = U\Theta U^{:}$. (2)

Then $B^{-\frac{1}{2}} = U\Theta^{-\frac{1}{2}} \ldots :$ (3)

Then equation (1) becomes:

$$\left((B^{-\frac{1}{2}})^{:} AB^{-\frac{1}{2}} - bI\right) m = 0 \qquad (4)$$

$$(m = \Theta^{\frac{1}{2}}U^{1}V)$$

$$(V = B^{-\frac{1}{2}}m)$$

Table XIV shows the matrix A.

The discriminant function weights are shown in Table XV.

The Wilks' lambda criterion for the discriminating power of the test battery was found to be .357. This value is significant at the .01 level.

Two vectors were obtained from the computation. The best one accounted for 94.77 percent of the discrimination. The second best vector accounted for 5.23 percent of the discrimination.

TABLE XIV

BETWEEN GROUPS MATRIX A
DISCRIMINANT FUNCTION GRADE XI

	Read.9	Lit.9	Lang.9	S.S.9	Math.9	Sci.9	SCAT Verb.
Read. 9	2,250.52	2,991.38	3,161.12	3,038.89	3,301.38	2,934.51	1,287.51
Lit. 9		6,429.50	5,135.90	5,913.47	6,219.69	5,573.61	1,381.00
Lang. 9			4,802.49	4,980.14	5,406.96	4,768.89	1,666.25
S. S. 9				5,535.83	5,835.12	5,237.67	1,491.08
Math. 9					7,005.65	5,663.46	1,461.86
Science 9						4,982.46	1,428.63
SCAT Verb.							821.76
SCAT Quant.							
Lit. 10							
Lang. 10							
S. S. 10							
Phys.Ed.10							
Short. 10							
Typ. 10							

Referring to Table XV, Shorthand 10 received the highest weighting for discriminating between the four groups, when Vector 1 is used. SCAT Quantitative received the second highest weighting and Language 10, the third. Vector 2 shows SCAT Verbal to have the highest weighting.

TABLE XIV (Continued)

	SCAT Quant.	Lit.10	Lang.10	S.S.10	Phys. Ed.10	Short. 10	Typ.10
Read. 9	1,701.51	3,426.26	3,483.70	4,306.76	1,130.04	9,200.29	4,180.97
Lit. 9	2,980.44	7,152.76	6,826.62	7,561.29	3,177.03	18,691.29	8,081.70
Lang. 9	2,686.05	5,801.32	5,749.70	6,774.52	2,246.35	15,531.01	6,891.51
S. S. 9	2,839.91	6,612.01	6,375.68	7,210.82	2,799.00	17,315.40	7,556.70
Math. 9	3,278.23	6,957.40	6,972.09	7,971.06	3,143.72	19,941.13	8,650.84
Sci. 9	2,742.69	6,238.63	6,070.77	6,907.19	2,648.27	16,627.70	7,260.47
SCAT Verb.	820.99	1,612.25	1,646.91	2,152.63	367.56	4,026.19	1,908.56
SCAT Quant.	1,572.92	3,349.15	3,345.95	3,881.46	1,417.82	9,349.72	4,096.15
Lit. 10		7,968.98	7,627.52	8,499.24	3,491.94	20,834.04	9,032.23
Lang. 10			7,420.60	8,389.64	3,314.40	20,479.17	8,908.55
S. S. 10				9,716.99	3,499.97	23,019.25	10,115.53
Phys.Ed.10					1,780.81	9,511.56	4,010.37
Short. 10						57,935.15	25,031.29
Typ. 10							10,868.67

The best discriminant function is $-.0527X_1 -.0096X_2 +.0048X_3 -.0149X_4 -.0536X_5 -.0324X_6 -.0963X_7 +.2121X_8 -.0210X_9 +.1145X_{10} +.0774X_{11} -.0158X_{12} +.9558X_{13} +.0729X_{14}$.

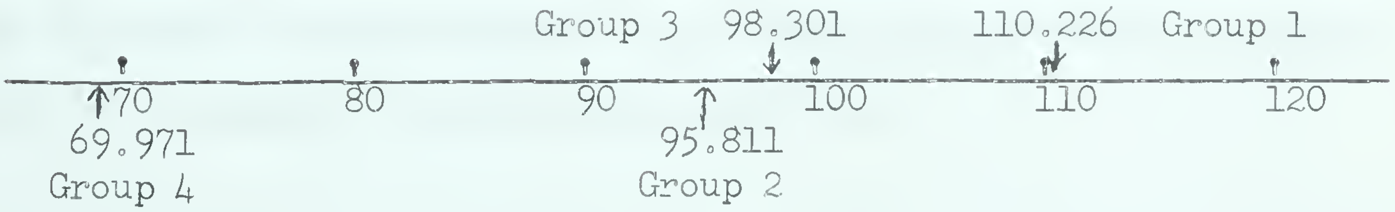
The second best discriminant function is $+.0244X_1 -.4234X_2 +.3086X_3 -.3362X_4 +.1390X_5 -.1121X_6 +.4800X_7 +.2008X_8 -.2149X_9 -.0374X_{10} +.4557X_{11} -.2132X_{12} -.0253X_{13} +.0892X_{14}$.

TABLE XV

WEIGHTS DISCRIMINANT FUNCTION GRADE XI

Variable	Vector 1	Vector 2
Reading 9	-.0527	.0244
Literature 9	-.0096	-.4234
Language 9	.0048	.3086
Social Studies 9	-.0149	-.3362
Mathematics 9	-.0536	.1390
Science 9	-.0324	-.1121
SCAT Verbal	-.0963	.4800
SCAT Quantitative	.2121	.2008
Literature 10	-.0210	-.2149
Language 10	.1145	-.0374
Social Studies 10	.0774	.4557
Physical Education 10	-.0158	-.2132
Shorthand 10	.9558	-.0253
Typewriting 10	.0729	.0892
Percent of Trace	94.77	5.23

This line shows the mean discriminant scores for each group.



CHAPTER V

SUMMARY, DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

SUMMARY

The purpose of the study and the findings were as follows:

1. to find a mark or group of marks from the Grade IX Departmental examination marks in Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, and Science 9; and the School and College Aptitude Test scores, Verbal and Quantitative; that was the best predictor of success in Grade X, Shorthand 10.

It was found that the best single predictor of Grade X, Shorthand 10 success was Science 9; the best group of two predictors was Science 9 and Language 9; the best group of three was Science 9, Language 9, and SCAT Verbal.

2. to find a mark or group of marks from the Grade IX Departmental examination marks in Reading 9, Literature 9, Language 9, Social Studies 9, Mathematics 9, and Science 9; and the School and College Aptitude Test scores, Verbal and Quantitative; and the Grade X year end marks in Literature 10, Language 10, Social Studies 10, Physical Education 10, Shorthand 10, and Typewriting 10; that was the best predictor of success in Grade XI, Shorthand 20.

It was found that the best single predictor of Grade XI, Shorthand 20 success was Shorthand 10; the best group of two predictors was Shorthand 10 and Language 10; the best group of three was Shorthand 10, Language 10 and Social Studies 10.

3. to find the variable or variables among the Grade IX Departmental examination marks and the School and College Ability Test scores that would discriminate best between the two groups of Grade X, Shorthand 10 students. The Group I students, described as Successful in this study, could take practiced dictation at a speed of 60 words per minute or over. (These students had a final mark of 65 percent or over in Shorthand 10.) The Group II students, described as Unsuccessful in this study, could not take practiced dictation at a speed of 60 words per minute. (These students had a final mark of under 65 percent in Shorthand 10.)

The discriminant function was found which discriminated best between Group I and Group II. Science, Language and Reading, in that order had the highest weights in the discriminant function and therefore were the best discriminators.

4. to find the variable or variables among the Grade IX Departmental examination marks and the School and College Ability Test scores that would discriminate best between the four groups of Grade XI, Shorthand 20 students. The Group I students, described as Successful in this study, could take unpracticed dictation at 80 words per minute or over and transcribe it accurately. (These students had a final mark of 65 percent or over in Shorthand 20.) The Group II students, described as Unsuccessful in this study, could not take unpracticed dictation at 80 words per minute. (These students had a final mark of under 65 percent in Shorthand 20.) The Group III students, described as Failures in this study, failed Shorthand 10 at the end of

Grade X so were inelligible to attempt Shorthand 20. The Group IV students were those who passed Shorthand 10, (obtained at least 50 percent on the final examination in Shorthand 10) but who did not attempt Shorthand 20. Group IV were called Dropouts in this study.

It was found that Shorthand 10 received the highest weighting for discriminating between the four groups. SCAT Quantitative received the second highest and Language 10 the third.

DISCUSSION

The seven public high schools in the city of Edmonton offer Pitman shorthand. The prediction studies read and reported on in this study, involved Gregg shorthand. The groups of variables, Science 9, Language 9, SCAT Verbal and Reading 9; Science 9, Language 9 and SCAT Verbal; Science 9 and Language 9; and Science 9 alone, in that order, were found to be the best to use in predicting success in Pitman Shorthand 10 in this study. The studies in Gregg shorthand appear to find English, (particularly Language and Spelling) and general scholastic average, to be the best predictors of success in Gregg shorthand.

A related ability must be required in learning Science 9 and Pitman Shorthand 10. There are many rules to be learned and many outlines to be memorized in Pitman shorthand. A well organized, consistent approach may be the factor that is common to the student of Science 9 and to the student of Pitman Shorthand 10 in Grade X.

This research should be carried out again using Gregg shorthand results from Alberta high schools in which the Gregg system of shorthand is taught to see if there is any relationship between Gregg shorthand and science.

The results of this study are subject to the following limitations:

1. The marks on the criterion variables, Shorthand 10, in the Grade X analyses and Shorthand 20, in the Grade XI analyses were the percentages assigned by individual teachers on their own tests.

2. The Grade X marks in Literature 10, Language 10, Social Studies 10, Physical Education 10, and Typewriting 10, used as variables in the Grade XI analyses were the percentages assigned by individual teachers on their own tests.

In future research projects of this nature these limitations could be partly removed by administering the same final tests in Shorthand 10 and in Shorthand 20 to all the students involved. The tests should be administered and marked by the same person to insure more uniformity in the final marks.

3. The percentage of the variance predicted in the criterion variable, Shorthand 10 is only a small percentage, 27.68, when eight variables are used in the regression equation; 25.08, when Science 9, Language 9, and SCAT Verbal are taken together as a group. Other variables are causing the remaining 72.32 percent of the variation. High school guidance counsellors must keep this fact in mind.

Results of this study show that the best group of three for

predicting success in Shorthand 10 was Science 9, Language 9, and SCAT Verbal. The best group of five for predicting success in Shorthand 20 was Shorthand 10, Language 10, Social Studies 10, Science 9 and SCAT Verbal. Shorthand 10 is the best predictor of success in Shorthand 20. Science and SCAT Verbal are first and third in order of importance in predicting success in Shorthand 10, and fourth and fifth in order of importance in predicting success in Shorthand 20.

Science 9, Language 9, and Reading 9, are the variables which have the most effect on the discriminant function in discriminating between the Successful and the Unsuccessful groups in Grade X. Counsellors, teachers and school administrators may be able to use this information.

In the Grade X multiple regression analysis the variables, in order of importance, that best predicted success in Grade X, Shorthand 10 were, Science 9, Language 9, SCAT Verbal and Reading 9. In the Grade X multiple discriminant analysis, Science 9, Language 9, and Reading 9, discriminated best between Group I, the Successful group and Group II, the unsuccessful group. The two methods of analyses of the Grade X data bring out similar results.

In the Grade XI regression analysis, the group of Shorthand 10, Language 10, and Social Studies 10, is the best predictor of success in Shorthand 20, accounting for 34.22 percent of the variance in the criterion. The group of Shorthand 10 and Language 10 predicts 33.38 percent of the variation in Shorthand 20 and is the second best predictor. Shorthand 10 is the best sole predictor of success in

Shorthand 20, predicting 25.53 percent of the variation. Shorthand 10 received the highest weighting for discriminating between the four groups, Successful, Unsuccessful, Failures and Dropouts in the Grade XI discriminant analysis. SCAT Quantitative received the second highest and Language 10 the third. The results from the discriminant analysis and the regression analysis on the same data tend to corroborate each other.

CONCLUSIONS

1. Science 9, Language 9 and SCAT Verbal are the best predictors when predicting success in Grade X, Shorthand 10, from the Grade IX marks and SCAT scores. Together they predict about a quarter of the variance in the shorthand mark.

2. Shorthand 10, Language 10 and Social Studies 10 are the best predictors when predicting success in Grade XI, Shorthand 20, from the Grade IX marks, SCAT scores and Grade X final marks. Together they predict about one third of the variance in the Shorthand 20 mark.

3. Science 9, Language 9 and Reading 9, are the three variables which discriminate best between the Grade X Successful and Unsuccessful groups.

4. Shorthand 10, SCAT Quantitative and Language 10 received the highest weighting for discriminating between the four groups, Successful, Unsuccessful, Failures and Dropouts in Grade XI.

IMPLICATIONS

The prerequisite for Shorthand 10 in the Alberta high schools is a "B" or better standing in Language 9 and Reading 9. In the light of the results of this study the student's mark in Science 9 might be taken into consideration as well.

If counselors and coordinators wanted to use a single Grade IX mark as a guide to predicting Shorthand success, Science 9 is the best according to this study.

Only about one quarter of the variation in Shorthand 10 can be accounted for with the variables used in this study. There is an urgent need for more research to be done using different variables in an attempt to find out what predicts the other three quarters of the variation in Shorthand 10. The variables used in this study predicted about one third of the variation in Shorthand 20. More research is needed to find what predicts the other two thirds.

A study, similar to this one, could be conducted using the results from schools offering Gregg shorthand in Alberta. For more reliable results, the same test should be administered to all students of Shorthand 10 and of Shorthand 20 at the end of the year.

BIBLIOGRAPHY

Allyn, Charles Vance, The Development of a Shorthand Aptitude Test Using Recognized Shorthand Strokes in Its Construction, National Business Education Quarterly, 1961-62.

Campbell, William Giles, Form and Style in Thesis Writing, Houghton Mifflin Company, Boston, The Riverside Press, Cambridge, 1954.

Christensen, Clifford M., University of Illinois, Multivariate Statistical Analysis of Differences Between Preprofessional Groups of College Students, The Journal of Experimental Education, Volume XXI, Number 3, March, 1953.

Briggs, Peter F., Wirt, Robert D., and Johnson, Rechelle, University of Minnesota, An Application of Prediction Tables to the Study of Delinquency, Journal of Consulting Psychology, American Psychological Association, Volume 25, Number 1, Pages 46-50, February, 1961.

Cheney, Truman M., University of Nevada, Reno, and Goodish, Naomi, Reno, (Nevada) High School, Analysis Between Certain Variables and Achievement in Beginning Shorthand, Journal of Business Education, Volume 38, Number 8, May, 1963.

Cooley, William W., and Lohnes, Paul R., Multivariate Procedures for the Behavioral Sciences, New York, Wiley, 1962.

Dame, J. Frank, President of Jones Business College, Jacksonville-Orlando-Miami, Florida, Guidance in Business Education, Journal of Business Education, Volume 38, Number 6, March, 1963.

Du Bois, Phillip H., Multivariate Correlative Analysis, Harper & Brothers Publishers, New York, 1957.

Johnson, Palmer, O., and Jackson, Robert W. B., Modern Statistical Methods, Descriptive and Inductive, Rand McNally & Company, Chicago, 1959.

Jones, Brian, M. Ed. Thesis, An Experimental Application of the Principle of Incongruity Tolerance to the Counselling Setting, University of Alberta, Edmonton, Alberta, August, 1962.

Kolpack, Otto, The Effects of the Teaching of Shorthand on Spelling Ability, National Business Education Quarterly, Volume 31, Number 1, p. 37, Fall, 1962.

Larson, Ruth L. and Eckersley, Ann L., The Selection of Students for Shorthand, Beacons on Business Education, Volume 40, Number 7, January, 1957.

Mordecai, Ezekiel, and Fox, Karl A., Methods of Correlation and Regression Analysis, Third Edition, John Wiley & Sons, Inc., New York, 1949.

Mordecai, Ezekiel, Methods of Correlation Analysis, Second Edition, New York, John Wiley & Sons, Inc., New York, London, Chapman & Hall, Limited, 1941.

Osborne, Elizabeth Agnes, The Relationship Between Certain Psychological Tests and Shorthand, New York Bureau of Publications, Teachers' College, Columbia University, p. 51, 1943.

Pauk, Walter, Director, Reading Study Center, Cornell University, Ithaca, New York, What's the Best Way to Predict Success in Shorthand? Business Education World, April, 1963.

Rao, C. Radhakrishna, Advanced Statistical Methods in Biometric Research, New York, John Wiley & Sons, Inc., London, Chapman & Hall, Limited, 1952.

Seeman, Julius, Organizing a Thesis Proposal, American Pshchologist, Volume 9, Number 12, December, 1959.

Seldon, William, Criteria for Selection of Stenographic Students, Journal of Business Education, Volume 37, Number 3, 1961.

Tiedeman, David V., and others, The Utility of the Airman Classification Battery for Assignment of Airmen to Eight Air Force Specialties, 1953.

Tintner, Gerhard, Some Applications of Multivariate Analysis to Economic Data, Journal of the American Statistical Association, Volume 41, Number 236, December, 1946.

Tschider, Irene R. A., History of Selected Studies in Shorthand Prognosis from 1914 to 1960, M. S., University of North Dakota, Grand Forks, 1960.

Turabian, Kate L., A Manual for Writers of Term Papers, Theses and Dissertations, Phoenix Books, The University of Chicago Press, 1955.

Waugh, Albert E. Professor of Economics, University of Connecticut, Elements of Statistical Method, McGraw-Hill Book Company, Inc., New York, Toronto, London, 1952.

Whittle, Marie, Do We have Criteria for Predicting Shorthand Success? The University of Texas, Austin, Texas, Business Education Forum, Volume XVI, Pages 25-26, March, 1962.

Wilks, Samuel Stanley, Elementary Statistical Analysis, Princetown University Press, Princeton, New Jersey, 1962.

Williams, E. J. D. Sc., Regression Analysis, New York, John Wiley & Sons, Inc., London, Chapman and Hall, Limited, 1959.

B29821